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AMSAT's® *Newsletter for the Amateur Radio Space Program*

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AMSAT OSCAR 10 Recovery Efforts Continue With Transponder Stuck On

Efforts aimed at restoring AMSAT OSCAR 10 to full capacity were hobbled late in August by a rapidly deteriorating IHU memory condition. The result is that AO-10 has been uncommandable since mid-August. Due to the random configuration of the memory, various modes of operation can result. The Mode B transponder has been locked on full-time since approximately August 20th. Consequently, unless a significant breakthrough in approach to the core problem is found, hopes for the long-term survival of the satellite are growing poorer.

According to VK5AGR quoting DJ4ZC, the situation with the memory is too dynamic and unstable to work with at present. Although efforts to find usable portions of memory will continue, earlier predictions of a rapid deterioration of memory once failures were detected seem to have been borne out. Moreover, a great deal of uncertainty surrounds the situation. In fact, the experimental nature of the efforts aimed at recovering AO-10 render predictions more speculative than many prefer.

Meanwhile, the AO-10 user community has anxiously sought guidance in two matters. First, they want to know if the Mode B transponder is available for use if found on. Second, they want to know what they can expect in the future regarding AO-10.

On Friday, August 29th, it was decided that light use of Mode B during part of the orbit would probably not notably decrease satellite life. The decision to allow minimum Mode B use was made against a background of little hard information about the AO-10 battery condition since the telemetry has been inoperative for more than a week. Other major uncertainties also clouded the picture and complicated the decision process.

The overall objective is to obtain as much useful life from AO-10 as possible. If nothing changes with the IHU situation, AO-10 will expire from lack of sunlight sometime this Autumn. Heavy transponder use will certainly expedite ultimate failure. Moderate to light use may not affect overall life at least for the present since ample sunlight is available for the next couple of weeks.

After that, however, the sun angle will reach a point where the batteries will obtain insufficient charge current from the solar panels. Because the IHU is inoperative, there is no way to re-orient the satellite for seasonal sun-angle changes and AO-10 will be lost.

The following AO-10 operating advice is provided:

"AMSAT OSCAR 10 has relapsed and is again in serious condition. The computer has resisted repairs attempted recently. The Mode B transponder has been on continuously jeopardizing the batteries. Since the telemetry is absent, the battery condition is unknown. AMSAT says until further notice Mode B may be used for QRP only between MA 60 and 140. QRP means 100 watts ERP or less. Watch for updates to this advisory."

New Japanese Satellite Proves a Hit; JARL Changes Name to Honor OSCAR

Operations on the new Japanese OSCAR have commenced with overwhelming success. Thousands of users, newcomers and veterans alike, have taken to the air to try out the latest offering in Amateur Satellite technology.

Meanwhile, the Japanese Amateur Radio League, JARL, has accepted an AMSAT/JAMSAT invitation to include the former JAS-1 in the proud family of OSCARs. According to JARL President Shozo Hara, JA1AN, henceforth JAS-1 will be called Fuji OSCAR 12 or simply FO-12. Mr. Hara responded to AMSAT's invitation August 27th in order to associate the JAS-1 program with the 25 year legacy of OSCARs. OSCAR celebrates his 25th Anniversary this December.

Known as JAS-1 prior to launch and Japan OSCAR 12 immediately after launch, the re-dedication to FO-12 joins Eastern and Western traditions in a gratifying synthesis of theme and purpose. All Japanese spacecraft including commercial and scientific payloads are renamed after flowers upon commencement of on-orbit space operations. For example, the Experimental Geodetic Payload (EGP), which was launched with JAS-1, was renamed Ajisai, Japanese for hydrangea. Similarly, JAS-1 was renamed Fuji (wisteria) by JARL. Later, the OSCAR family name was added and it became Fuji OSCAR 12.

Users of FO-12 have found it sensitive and fun. It's easily accessed using well under the 100 watt ERP level when transponder loading is low. The most frequent comment

voiced by users remarks on the high Doppler shift and rapid antenna pointing required to stay on target. Others have bemoaned the fading of the downlink. Sources indicate the QSB is due to spacecraft tumbling and should dampen out in a few weeks. There is already some indication of reduction in tumble-QSB these sources conclude.

Many veterans of AO-8, Mode J, who have been only sporadically active on AO-10, are finding a great deal of fun with FO-12.

FO-12 was launched August 12 in a letter-perfect launch from Japan.

FO-12 Operating Frequencies and Procedures

JARL and JAMSAT have provided the following specifications for FO-12.

The uplink for FO-12 Mode JA is: 145.900 through 146.000 MHz.

The corresponding downlink band is: 435.900 through 435.800 MHz.

This is an inverting, linear transponder.

Operating frequencies for Mode JA, used for SSB and CW, may be determined as follows. The sum of the uplink and downlink frequencies equals 581.800 MHz exclusive of Doppler shift. For example, if the uplink is 145.920 MHz, the downlink will be 435.880 MHz. Doppler shift can be as high as plus or minus 5 kilohertz on the downlink passband and 8 kHz on the beacon.

The beacon frequency on-orbit has been measured at 435.797 MHz.

The downlink power is up to 2 watts PEP EIRP. The downlink antennas are LHCP polarized while the uplink antenna is linear. About 100 watts ERP or less is the recommended uplink.

The bandplan provided by JARL recommends CW users in the lower third of the passband from 435.800 through 435.835 MHz. SSB users should use the upper third from 435.865 to 435.900 MHz. Mixed SSB and CW are welcome in the center third.

To maximize passband usefulness, JARL recommends you control your uplink frequency to maintain a constant downlink frequency as heard at your QTH. The reasons for this are fairly subtle but seemed to work on AO-8, Mode J.

Differences in Doppler shift between occupants of the passband can cause some occupants to move across the downlink passband faster than others. The result is that "collisions" between QSOs are more likely than on other current satellites. Consequently, it is recommended that the same procedure used on AO-8, Mode J be used on FO-12, Mode J. That is, once you have found a clear spot in the downlink passband, try to remain there by adjusting your UPLINK frequency only.

Mode JD, the digital Mode J, could be activated in a few weeks.

Ballots Mailed

AMSAT Headquarters says the 1986 Director election ballots have been mailed. All members of record as of August 21 should receive their ballots in a few days. Read the instructions carefully and return the ballots promptly in the envelope provided. Return only the ballot in the envelope provided. Do not enclose orders for anything nor any special requests. Including anything but the ballots in the envelope provided will only assure your request will be delayed since the ballots will be batch-processed in early November. Again, please follow the instructions carefully and return the ballots promptly. Above all, please cast your vote and help determine AMSAT's leadership and thus its future course.

AMSAT Forum At New England Division ARRL Convention To Feature Future OSCARs

by Andrew Deskur, KA1M, MA Area Coordinator

The New England Division ARRL Convention will be held in Boxboro, Massachusetts on the weekend of October 18 and 19. This is the 25th gathering of the Division. As in recent years AMSAT will be well-represented with a booth in the main exhibit hall. An AMSAT forum is scheduled for Saturday afternoon. AMSAT President Vern "Rip" Riportella, WA2LQQ, is the featured forum speaker. Rip will update attendees on AO-10 status, Phase 3C, FO-12 and a glimpse at Phase 4 plans.

Volunteers to help staff the booth are sought. Not only is this a great way to share your enthusiasm and knowledge about Amateur Radio satellites but it's a good way to meet other local AMSAT members. If you're planning to attend the convention and are willing to help out, please contact Andrew Deskur, KA1M, AMSAT's convention organizer and liaison. The address is: 71 Adams Avenue, Methuen, MA, 01844-2119. You may call at 617-688-0210 (home) or 617-967-3620 (office).

Initial Mode JD Tests A-OK

by Masaya Fukasawa, JR1FIG

After careful examination of the FO-12 modules, first activation of JTD (Mode J - Digital Transmitter) was carried out on August 30. According to JG1LDV (a member of JARL Amateur Satellite Committee, as well as JAMSAT), JTD power was turned ON twice during the window of orbit #218. It sent strong signals as expected. No information was sent on this occasion since the on-board computer remained OFF.

Since the output power of JTD downlink is about 1 watt, it can be heard 10 dB stronger than JTA's CW beacon. If you can receive JTA beacon clearly, you should easily decode the PSK signal from JTD providing correct antenna and frequency tracking is performed.

The next expected step is to turn the power ON for a whole orbit or more. In this case, you can practice the antenna/frequency tracking of FO-12 with that downlink signal. If your demodulator locks on the downlink carrier (or HDLC flags) continuously, you should be able to receive PSK telemetry which seems the next step in the very near future.

Mini-Tutorial: Ajisai — Flashing Flower

by Tom Clark, W3IWI

[The Experimental Geodetic Payload, EGP, was launched by Japan with Fuji OSCAR 12 on August 12, 1986. Since renamed Ajisai (hydrangea), the experiment has yielded excellent results in ranging for the dozens of scientists around the world who have used it in its first few weeks of operation. It is, moreover, easily visible to layman on the ground given proper sun-satellite-observer geometries. In the following Mini-Tutorial, Dr. Tom Clark, W3IWI, AMSAT President Emeritus and a working NASA scientist in a related field, expounds on this interesting spacecraft. — Ed.]

Ajisai, the "Mirrorball" is totally passive and has no active electronics on board. It is a sphere 2.15 meters in diameter having a mass of 685 kg. The structural members of the spacecraft are made of fiber-reinforced composite resin material. There are two types of reflectors on the surface: (a) corner reflectors and (b) mirrors.

The Corner Reflectors

The corner reflectors consist of 120 clusters of 12 cubes each around the entire periphery for a total of 1436 (Yes, I know that 12x120 = 1440 -- there are four missing for structural reasons).

All laser retro-reflectors are identical. Each is an tetrahedron; the corner of a cube. Three of the faces meet at 90 degree angles at the vertex. The fourth is the illuminated face. The illuminated face is an equilateral triangle with sides of 42 mm. Looking at the reflector from the illuminated face, the maximum depth is 17 mm. Each unit is made of fused silica glass polished to 0.1 wavelengths in the visual spectrum and has a mass of 9g.

These corner reflectors are the targets for the laser tracking stations. Laser tracking is so precise that the data must be corrected for the 1.07 meter distance from the corner reflectors to the center of mass of the satellite. The duration of the laser pulses bounced off the satellite ranges from about 200 picoseconds (200 trillioneths) to a few nanoseconds (billioneths) depending on which laser system is doing the ranging. The laser pulses thus have a spatial length between 4 and 50 cm.

Measuring the round-trip time of these light pulses gives a very precise determination of the satellite-to-observer distance. This delay naturally varies as the satellite moves across the sky and as the observer moves since his observation platform is a rotating earth.

The Mirrors

There are a total of 318 mirror segments. Each has a convex spherical shape with a radius of curvature in the 8.4 to 9 meter range. These mirror segments cover 85% of the surface of the ball. The mirrors are designed to reflect sunlight and are what you see when you look at the satellite visually.

At separation the H-1 launcher should have had the "Mirrorball" spinning at 40 rpm. Given the geometry of the mirrors, you should see 6 flashes per rotation, i.e., 2 flashes per second. And, given the curvature of the mirrors, each flash should have a duration of 5 milliseconds. Thus, light reaches you about 1% of the time. Since your eye is a good integrator of such short pulses, you don't perceive them as being so brief. (Movies and television send you discrete frames every 30-40 milliseconds and yet to the eye/brain, motion seems continuous).

The Japanese expect the apparent brightness of the satellite (actually the sun reflected off the mirrors) to be in the 1st to 4th magnitude range. (One magnitude unit = 4 dB; 1st magnitude is brighter than 4th magnitude. On a moonless night with very clear skies and with no background light the naked eye can see stars as faint as 5th to 6th magnitude). Since your eye detects the brighter end of this range more easily, when you are able to see the "Mirrorball", it is around 2nd magnitude; roughly comparable to Polaris.

For AMSAT members interested in observing Ajisai, tracking data is being provided by AMSAT. FO-12 remains fairly close to Ajisai (less than a degree in azimuth and elevation as seen from earth) so when FO-12 is heard, Ajisai may be seen if lighting conditions are correct. Best viewing times are within a few hours after dusk and before dawn. Watch for its white-light flashing twice per second.

Short Bursts

- According to G3IOR quoting UA3CR, neither RS-9 nor RS-10 will be launched this year. The launch opportunity apparently has evaporated and they will be obliged to wait until next year.
- A computerized antenna controller or auto-tracking system article appears in the September *QST*. The article by Jon Bloom, KE3Z, of ARRL is the culmination of an extensive project to develop and document a flexible system which will work with many rotors and computer programs.
- In *ASR* #128 we mentioned that K7ID was the only individual to have ever achieved a Z8 rating in the Mode B ZRO test. Not so! W7ID is the identity of the REAL Mode B Z8! We're sorry for the slipup. Incidentally, Jeff, W7ID, has promised us a short article and photos of his superb station in Boise that proved so superior in weak signal work on 2 meters.

Tech Tip #2: NASA Orbital Element Conversion to AMSAT ORBS Format

by Ralph Wallio, WØRPK, AMSAT V-P Operations

Orbital element data sets ordered from NASA'a Goddard Space Flight Center are given in the following two-line format:

```
1 NNNNNU NNNNNAAA NNNNN.NNNNNNNN +.NNNNNNNN
  +NNNNN-N +NNNNN-N N NNNNN
2 NNNNN NNN.NNNN NNN.NNNN NNNNNNN NNN.NNNN
  NNN.NNNN NN.NNNNNNNN NNNNN
```

Line 1

01-01 Line number of element data
03-07 Satellite (catalog) number
08-08 U = Unclassifed
10-11 International designator (last two digits of launch year)
12-14 International designator (launch number of the year)
15-17 International designator (sequential piece of launch)
19-20 Epoch year (last two digits of year)
21-32 Epoch day (Julian day and fractional portion of the day)
34-43 First Time Derivative of the Mean Motion
or Ballistic Coefficient (depending of ephemeris type)

45-52 Second Time Derivative of Mean Motion (blank if n/a)
54-61 BSTAR Drag Term if GP4 general perturbation theory was used. Otherwise, Radiation Pressure Coefficient.
63-63 Ephemeris Type
65-68 Element Number
69-69 Check Sum (modulo 10)
(letters, blanks, periods = 0; minus sign = 1)

Line 2

01-01 Line number of element data
03-07 Satellite number
09-16 Inclination [degrees]
18-25 Right Ascension of the Ascending Node [degrees]
27-33 Eccentricity (decimal point assumed)
35-42 Argument of Perigee [degrees]
44-51 Mean Anomaly [degrees]
53-63 Mean Motion [revs per day]
64-68 Revolution number at epoch [revs]
69-69 Check sum (modulo 10)

All other columns are blank or fixed.

Example (NUSAT):

```
1 15666U 85034 B 86190.08784406 +.00023674 +00000-0
  +74487-4 0 03906
2 15666 056.9897 177.3795 0015038 070.3444 289.9068
  15.90818923 68819
```

This NASA two-line format is converted to AMSAT's ORBS orbital element format by a program written and operated by Phil Karn, KA9Q, AMSAT Assistant Vice-President of Engineering. Phil's program adds derived values for Semi major axis, Anom period, Apogee, Perigee and Reference Perigee with the result as follows:

Satellite:	nusat
Catalog number:	15666
Epoch time:	86190.08784406
Wed Jul 9 02:06:29.726 1986 UTC	
Element set:	390
Inclination:	56.9897 deg
RA of node:	177.3795 deg
Eccentricity:	0.0015038
Arg of perigee:	70.3444 deg
Mean anomaly:	289.9068 deg
Mean motion:	15.90818923 rev/day
Decay rate:	0.00023674 rev/day^2
Epoch rev:	6881
Semi major axis:	6677.770 km
Anom period:	90.519416 min
Apogee:	323.004 km
Perigee:	302.920 km
Ref perigee:	3111.10008325
Wed Jul 9 02:24:07.192 1986 UTC	

The AMSAT ORBS orbital element format is the standard around which most tracking programs available through the AMSAT Software Exchange are written.

Thanks to T.S. Kelso, SYSOP of the CELESTIAL BBS (512-892-4180), and to Phil Karn, KA9Q, for their assistance with the above information.

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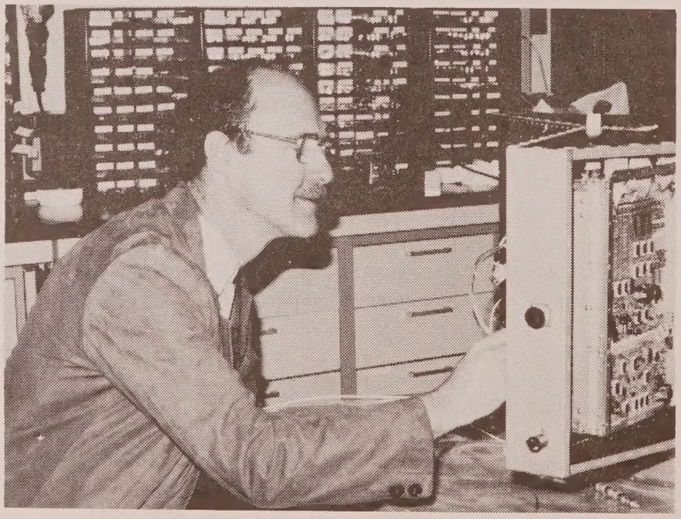

Behind the scenes on all OSCARs since AO-6 has been Dick Daniels, W4PUJ. Here he checks out the P3C hardware in Golden, CO. Dick built the Propellant Flow Assembly for P3C as he did for AO-10.

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